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When you think of  
the DACS,  
think of...



Software Tools  
You Can Use.

### **Tempus: A Software Process Improvement Measurement Tool**

An imperative of twenty-first century software development is continual process improvement. If you are standing still, you are losing ground. Developers and maintainers of real-time software are looking for ways to improve their ability to deal with both technical and management challenges as their systems become ever more capable, complex and interoperable. Recent advances in software measurement such as the Tempus measure provide real-time developers with a distinct advantage. The Tempus measure offers reduced costs in achieving real-time performance budgets and improved change management with impact analysis. As an added bonus, the Tempus measure offers a better way to track size than counting lines of code.

#### **Advantages of the Tempus Measure**

The Tempus measure represents a recent advancement in software measurement research. Because it is derived from source code, it provides real-time developers with the following distinct advantages:

- Reduced costs to achieve real-time performance budgets
- Improved change management with impact analysis
- Better way to track size



A Modus Operandi Product

## **Locating Performance Problems in your Ada Source Code**



## **DACS Software Tools**



[www.dacs.dtic.mil](http://www.dacs.dtic.mil)

## Identifying Performance Problems in Ada Source Code

The DACS can help your real-time software developers and maintainers to automatically identify performance hot spots in their Ada Source Code. We utilize the Tempus (tm) tool from Modus Operandi.

## Reduced Costs to Achieve Real-Time Performance Budgets

Four factors contribute to the costliness of achieving real-time performance budgets.

1. There are currently no good methods to estimate execution time.
2. It is very expensive to instrument and measure actual real-time performance on target hardware. Realistic operational testing is expensive in terms of resources such as manpower, fuel, power, and time.
3. Measuring actual real-time performance, by its very nature, cannot be done until late in the development life cycle where the risk of software change is high and the schedule may not leave adequate time to repair significant performance deficiencies. If the target hardware is being developed concurrently with the software, it may not even be possible to measure performance on the target hardware until very late indeed.
4. Even when you know that performance is inadequate, it is very difficult to determine *where* to focus the improvement effort.

## Early Estimation and Prevention

The Tempus measure addresses factors 1, 2 and 3 listed above because it is derived from source code. As soon as source code is available, regardless of the degree of completion, the measure may be computed. In fact, the measure is still valuable when computed from incomplete source code or PDL.

## Identifying Hot Spots

The Tempus measure can be used to identify parts of the code that have relatively high  $t_{NOP}$  values. Coupled with other knowledge derived from the source code, this information points out potential performance hot spots. Often it is not just the execution time of a single routine or block of code that is the issue, but rather the number of times that that block of code executes. For example, code inside a loop with a high number of iterations, or a routine that is called many times, may have a lengthy total execution time even though one pass through the piece of code is relatively inexpensive. If such a block of code is inefficiently implemented, it may constitute a target for performance improvement.

Another way to identify hot spots is to compare the minimum and maximum  $t_{NOP}$  values for different branches within a single routine. If the range between min and max values is large, this indicates that performance may vary greatly depending on which branch is executed. The high-value branches are candidates for further investigation and possible performance improvement.

## Improved Change Management with Impact Analysis

Another recurring theme in process improvement is to proactively manage and control change. Whether during initial software development or later upgrades and maintenance, change is as dangerous as it is inevitable. Unless the process is sufficiently disciplined, every change to the software is a potential source for degradation of quality.

Incorporation of the Tempus measure adds discipline to the process in the following ways:

- Alerts developers by percolation of changes of  $t_{NOP}$  values in low level code upward to calling routines.
- Assists developers in assessing the impact of a code change to real-time performance prior to actual measurement.



## Conclusion

Measurement is crucial to achieving a disciplined software development process. This is especially important when dealing with the challenges of developing and maintaining real-time software. The Tempus measure offers significant benefits by allowing software developers and maintainers to assess real-time performance much earlier in the development life cycle than is possible with traditional instrumentation approaches.